

Detergents comprising amylase and acetonitrile  
derivatives

The present invention relates to enzyme containing  
5 detergents comprising besides customary constituents an  
amylase from *Bacillus amyloliquefaciens* and certain  
active bleach activating substances.

Laundry detergents, in addition to the ingredients  
10 vital to the laundering process, such as surfactants  
and builder materials, generally comprise further  
constituents, which may be grouped together under the  
heading of wash auxiliaries and which embrace such  
different active substance groups as foam regulators,  
15 graying inhibitors, bleaches, bleach activators, and  
color transfer inhibitors. Such auxiliaries also  
include substances which assist the surfactant  
performance by means of enzymatic degradation of stains  
present on the textile. The same applies, mutatis  
20 mutandis, to cleaning products for hard surfaces. As  
well as the proteases, which assist in removing  
proteins, and the fat-cleaving lipases, particular  
importance in this context attaches to the amylases.  
Amylases have the function of facilitating the removal  
25 of starchy stains by means of catalytic hydrolysis of  
the starch polysaccharide, and have been used for this  
purpose for a fairly long time in dishwashing  
detergents, but also in detergents for use in textile  
laundering. In by far the great majority of cases the  
30 amylase involved has comprised a heat-stable amylase  
from *Bacillus licheniformis*, which is customary in  
commerce under the designation Termamyl®, for example.  
More recently, there has been increased use in such  
compositions of genetically manipulated amylases; that  
35 is, amylases whose amino acid sequence has been  
altered, using gene technology methods, in comparison  
to naturally occurring amylases. As well as increasing  
their capacity to perform, the objective of genetically  
modifying amylases is essentially to enhance the

stability of the enzyme, especially their stability to attack by oxidizing agents. One approach toward achieving this objective, which was proposed in International Patent Application WO 94/18314, consists  
5 in removing particularly oxidation-susceptible amino acids, such as methionine, tryptophan, cysteine or tyrosine, from the amino acid sequence of the amylase, or replacing them by other amino acids more stable to oxidation. A similar approach is proposed in  
10 International Patent Application WO 95/21247, which recommends replacing at least one methionine in the amylase amino acid sequence by an amino acid which is neither methionine nor cysteine.

15 Although such genetic modifications may lead to improved amylase stability under certain application conditions, they do not help to increase the contribution of the amylase to the wash or cleaning performance of corresponding compositions comprising  
20 the amylase.

It has surprisingly now been found that the combination of a naturally occurring  $\alpha$ -amylase with certain bleach activating substances of the acetonitrile derivative  
25 type leads to unexpectedly synergistic performance improvements when used in detergents.

The invention accordingly provides an amylase containing detergent which comprises  $\alpha$ -amylase from  
30 *Bacillus amyloliquefaciens* and at least one compound of the general formula I



35 where  $R^1$ ,  $R^2$  and  $R^3$  independently of one another are alkyl, alkenyl or aryl groups of 1 to 18 carbon atoms, it also being possible for groups  $R^2$  and  $R^3$  to be part of a heterocycle including the nitrogen atom and, if desired, further heteroatoms, and X is a charge

equalizing anion, as well as customary ingredients compatible with such constituents.

5 The invention further provides for the use of such a combination for enhancing the cleaning performance of detergents, especially with respect to starchy and/or colored stains, especially tea based stains, when used in detergent solutions, especially aqueous detergent solutions, which comprise a peroxygen compound. In this  
10 context, cleaning performance with respect to colored stains is to be understood in its widest context and embraces not only the bleaching of soil present on the textile and the bleaching of soil which is in the wash liquor, having become detached from the textile, but  
15 also the oxidative destruction of textile colors present in the wash liquor, having become detached from textiles under the wash conditions, before they are able to attach to different-colored textiles. Also, in the context of use in cleaning solutions for hard  
20 surfaces, this term refers both to the bleaching of soil present on the hard surface, especially tea, and to the bleaching of soil which is present in the dishwashing liquor, having become detached from the hard surface.

25  $\alpha$ -Amylase from *Bacillus amyloliquefaciens* has been known for a long time, for example, from the U.S. Patent US 1 227 374. It is available commercially, for example, under the designation Amylase BAN®.

30 A composition of the invention contains preferably from 0.001 mg to 0.5 mg, in particular from 0.02 mg to 0.3 mg, of amylolytic protein per gram of the overall composition. The protein concentration may be  
35 determined using known methods, such as the bicinchonic acid technique (BCA technique, Pierce Chemical Co., Rockford, IL) or the biuret technique (A.G. Gornall, C.S. Bardawill and M.M. David, J. Biol. Chem. 177, 751-766, 1948).

The preparation of compounds of formula I may take place by, or along the lines of, known processes, such as that published, for example, by Abraham in Progr. Phys. Org. Chem. 11 (1974), p. 1ff., or by Arnett in J. Am. Chem. Soc. 102 (1980), p. 5892ff. Compounds of general formula I were described in European Patent Applications EP 0 464 880, EP 0 458 396 and EP 0 790 244, or in International Patent Applications WO 96/40661 and PCT/EP 97/06527.

Particular preference is given to the use of compounds of formula I wherein  $R^2$  and  $R^3$  including the quaternary nitrogen atom form a morpholinium ring. In these compounds,  $R^1$  is preferably an alkyl group of 1 to 3 carbon atoms, in particular a methyl group.

The anions  $X^-$  include in particular the halides such as chloride, fluoride, iodide and bromide, nitrate, hydroxide, hexafluorophosphate, sulfate, hydrogen sulfate, methosulfate and ethosulfate, chlorate, perchlorate, and the anions of carboxylic acids, such as formate, acetate, benzoate or citrate. It is preferred to use compounds of formula I wherein  $X^-$  is sulfate, hydrogen sulfate or methosulfate.

An acetonitrile derivative of formula I is present in compositions of the invention preferably in amounts of from 1% by weight to 10% by weight, in particular from 2% by weight to 7% by weight.

In addition to the active substance combination used in accordance with the invention, the detergents of the invention, which may be present as solids, especially pulverulent solids, in postcompacted particle form, as homogeneous solutions or suspensions may in principle comprise all known ingredients which are customary in such compositions. The compositions of the invention may in particular comprise builder substances,

surfactants, bleaches based on organic and/or inorganic peroxygen compounds, additional bleach activators, water miscible organic solvents, additional enzymes, sequesterants, electrolytes, pH regulators, and further  
5 auxiliaries, such as optical brighteners, graying inhibitors, color transfer inhibitors, foam regulators, silver corrosion inhibitors, and also dyes and fragrances.

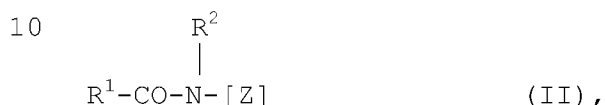
10 The compositions of the invention may comprise a surfactant or two or more surfactants, suitable surfactants comprising in particular anionic surfactants, nonionic surfactants and mixtures thereof, but also cationic, zwitterionic and amphoteric  
15 surfactants.

Suitable nonionic surfactants are, in particular, alkyl glycosides and ethoxylation and/or propoxylation products of alkyl glycosides or linear or branched  
20 alcohols having in each case 12 to 18 carbon atoms in the alkyl moiety and from 3 to 12, preferably from 4 to 10, alkyl ether groups. It is also possible to use corresponding ethoxylation and/or propoxylation products of N-alkylamines, vicinal diols, fatty acid  
25 esters and fatty acid amides, which in terms of the alkyl moiety correspond to the aforementioned long chain alcohol derivatives, and also alkylphenols having 5 to 12 carbon atoms in the alkyl radical.

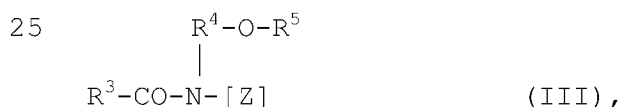
30 Nonionic surfactants used are preferably alkoxyated, advantageously ethoxylated, especially primary, alcohols having preferably 8 to 18 carbon atoms and on average from 1 to 12 mol of ethylene oxide (EO) per mole of alcohol, in which the alcohol radical may be  
35 linear or, preferably, methyl-branched in position 2 and/or may comprise linear and methyl-branched radicals in a mixture, as are commonly present in oxo alcohol radicals. In particular, however, preference is given to alcohol ethoxylates containing linear radicals from

alcohols of natural origin having 12 to 18 carbon atoms, e.g., from coconut, palm, tallow fatty or oleyl alcohol and on average from 2 to 8 EO per mole of alcohol. Preferred ethoxylated alcohols include, for example, C<sub>12-14</sub> alcohols containing 3 EO or 4 EO, C<sub>9-11</sub> alcohols containing 7 EO, C<sub>13-15</sub> alcohols containing 3 EO, 5 EO, 7 EO or 8 EO, C<sub>12-18</sub> alcohols containing 3 EO, 5 EO or 7 EO, and mixtures thereof, such as mixtures of C<sub>12-14</sub> alcohol containing 3 EO and C<sub>12-18</sub> alcohol containing 7 EO. The stated degrees of ethoxylation represent statistical mean values, which for a specific product may be an integer or a fraction. Preferred alcohol ethoxylates have a narrowed homolog distribution (narrow range ethoxylates, NREs). In addition to these nonionic surfactants it is also possible to use fatty alcohols containing more than 12 EO. Examples thereof are (tallow) fatty alcohols containing 14 EO, 16 EO, 20 EO, 25 EO, 30 EO or 40 EO. Especially in detergents for use in machine dishwashing processes, it is common to use extremely low-foaming compounds. These include, preferably, C<sub>12-C18</sub> alkyl polyethylene glycol-polypropylene glycol ethers having in each case up to 8 mol of ethylene oxide and propylene oxide units in the molecule. However, it is also possible to use other nonionic surfactants which are known to be low-foaming, such as, for example, C<sub>12-C18</sub> alkyl polyethylene glycol-polybutylene glycol ethers having in each case up to 8 mol of ethylene oxide and butylene oxide units in the molecule, and also endgroup-capped alkyl polyalkylene glycol mixed ethers. Particular preference is also given to the hydroxyl-containing alkoxyated alcohols as are described in European Patent Application EP 0 300 305, referred to as hydroxy mixed ethers. The nonionic surfactants also include alkyl glycosides of the general formula RO(G)<sub>x</sub>, where R is a primary straight-chain or methyl-branched aliphatic radical, especially an aliphatic radical methyl-branched in position 2, containing 8 to 22, preferably 12 to 18, carbon atoms, and G represents a

glycose unit having 5 or 6 carbon atoms, preferably glucose. The degree of oligomerization, x, which indicates the distribution of monoglycosides and oligoglycosides, is any desired number - which, as a  
5 variable to be determined analytically, may also be a fraction - between 1 and 10; preferably, x is from 1.2 to 1.4. Further suitable surfactants are polyhydroxy fatty acid amides of the formula (II)



where R<sup>1</sup>CO is an aliphatic acyl radical having 6 to 22  
15 carbon atoms, R<sup>2</sup> is hydrogen or an alkyl or hydroxyalkyl radical having 1 to 4 carbon atoms, and [Z] is a linear or branched polyhydroxyalkyl radical having 3 to 10 carbon atoms and from 3 to 10 hydroxyl groups. The polyhydroxy fatty acid amides are derived  
20 preferably from reducing sugars having 5 or 6 carbon atoms, especially glucose. The group of the polyhydroxy fatty acid amides also includes compounds of the formula (III)



where R<sup>3</sup> is a linear or branched alkyl or alkenyl  
30 radical having 7 to 12 carbon atoms, R<sup>4</sup> is a linear, branched or cyclic alkylene radical or an arylene radical having 2 to 8 carbon atoms and R<sup>5</sup> is a linear, branched or cyclic alkyl radical or an aryl radical or an oxyalkyl radical having 1 to 8 carbon atoms,  
35 preference being given to C<sub>1</sub>-C<sub>4</sub> alkyl radicals or phenyl radicals, and [Z] is a linear polyhydroxyalkyl radical whose alkyl chain is substituted by at least two hydroxyl groups, or alkoxyated, preferably ethoxyated or propoxyated, derivatives of said radical. Here too,  
40 [Z] is preferably obtained by reductive amination of a

sugar such as glucose, fructose, maltose, lactose, galactose, mannose, or xylose. The N-alkoxy- or N-aryloxy-substituted compounds may then be converted to the desired polyhydroxy fatty acid amides, for example, in accordance with the teaching of International Patent Application WO 95/07331 by reaction with fatty acid methyl esters in the presence of an alkoxide as catalyst. A further class of nonionic surfactants used with preference, which are used either as sole nonionic surfactant or in combination with other nonionic surfactants, in particular together with alkoxylated fatty alcohols and/or alkyl glycosides, are alkoxylated, preferably ethoxylated, or ethoxylated and propoxylated, fatty acid alkyl esters, preferably having 1 to 4 carbon atoms in the alkyl chain, especially fatty acid methyl esters, as are described, for example, in Japanese Patent Application JP 58/217598, or those prepared preferably by the process described in International Patent Application WO 90/13533. Nonionic surfactants of the amine oxide type, examples being N-cocoalkyl-N,N-dimethylamine oxide and N-tallowalkyl-N,N-dihydroxyethylamine oxide, and of the fatty acid alkanolamide type, may also be suitable. The amount of these nonionic surfactants is preferably not more than that of the ethoxylated fatty alcohols, in particular not more than half thereof. Further suitable surfactants include those known as gemini surfactants. This term is used generally to refer to those compounds which possess two hydrophilic groups per molecule. These groups are generally separated from one another as a result of what is known as a spacer. This spacer is generally a carbon chain, which should be long enough to give the hydrophilic groups a sufficient spacing to allow them to act independently of one another. Surfactants of this kind are generally notable for an unusually low critical micelle concentration and the ability to reduce greatly the surface tension of water. In exceptional cases, however, the expression gemini surfactants is used to



embrace not only dimeric but also, correspondingly, trimeric surfactants. Examples of suitable gemini surfactants are sulfated hydroxy mixed ethers in accordance with German Patent Application DE 43 21 022  
5 or dimer alcohol bis- and trimer alcohol tris-sulfates and ether sulfates in accordance with German Patent Application DE 195 03 061. Endgroup-capped dimeric and trimeric mixed ethers in accordance with German Patent Application DE-A-195 13 391 are notable in particular  
10 for their bi- and multifunctionality. Thus said endgroup-capped surfactants possess good wetting properties and are low-foaming, so making them particularly suitable for use in machine washing or cleaning processes. However, it is also possible to use  
15 gemini-polyhydroxy fatty acid amides or polypolyhydroxy fatty acid amides, as described in International Patent Applications WO 95/19953, WO 95/19954, and WO 95/19955.

Suitable anionic surfactants are, in particular, soaps  
20 and those containing sulfate or sulfonate groups. Preferred surfactants of the sulfonate type are C<sub>9-13</sub> alkylbenzenesulfonates, olefinsulfonates, i.e., mixtures of alkenesulfonates and hydroxyalkanesulfonates, and also disulfonates, as are obtained, for  
25 example, from C<sub>12-18</sub> monoolefins having a terminal or internal double bond by sulfonating with gaseous sulfur trioxide followed by alkaline or acidic hydrolysis of the sulfonation products. Also suitable are alkanesulfonates, which are obtained from C<sub>12-18</sub> alkanes,  
30 for example, by sulfochlorination or sulfoxidation with subsequent hydrolysis or neutralization, respectively. Likewise suitable, in addition, are the esters of  $\alpha$ -sulfo fatty acids (ester sulfonates), e.g., the  $\alpha$ -sulfonated methyl esters of hydrogenated coconut,  
35 palm kernel or tallow fatty acids, which are prepared by  $\alpha$ -sulfonation of the methyl esters of fatty acids of plant and/or animal origin having 8 to 20 carbon atoms in the fatty acid molecule, followed by neutralization to give water-soluble mono-salts. Preferably, these

comprise the  $\alpha$ -sulfonated esters of hydrogenated coconut, palm, palm kernel or tallow fatty acids, it being possible as well for sulfonation products of unsaturated fatty acids, e.g. oleic acid, to be present  
5 in small amounts, preferably in amounts of not more than about 2 to 3% by weight. Particular preference is given to  $\alpha$ -sulfo fatty acid alkyl esters having an alkyl chain of not more than 4 carbon atoms in the ester group, examples being methyl esters, ethyl  
10 esters, propyl esters, and butyl esters. With particular advantage, the methyl esters of the  $\alpha$ -sulfo fatty acids (MES) are used, and also their saponified di-salts. Further suitable anionic surfactants are sulfated fatty acid glycerol esters which are the  
15 monoesters, diesters and triesters, and mixtures thereof, as obtained in the preparation by esterification of a monoglycerol with from 1 to 3 mol of fatty acid or in the transesterification of triglycerides with from 0.3 to 2 mol of glycerol.  
20 Preferred alk(en)yl sulfates are the alkali metal salts, and especially the sodium salts, of the sulfuric monoesters of  $C_{12}$ - $C_{18}$  fatty alcohols, examples being those of coconut fatty alcohol, tallow fatty alcohol, lauryl, myristyl, cetyl or stearyl alcohol, or of  
25  $C_{10}$ - $C_{20}$  oxo alcohols, and those monoesters of secondary alcohols of this chain length. Preference is also given to alk(en)yl sulfates of said chain length which contain a synthetic straight-chain alkyl radical prepared on a petrochemical basis, these sulfates  
30 possessing degradation properties similar to those of the corresponding compounds based on fatty-chemical raw materials. From a detergents standpoint,  $C_{12}$ - $C_{16}$  alkyl sulfates and  $C_{12}$ - $C_{15}$  alkyl sulfates, and also  $C_{14}$ - $C_{15}$  alkyl sulfates, are particularly preferred. In  
35 addition, 2,3-alkyl sulfates, which may for example be prepared in accordance with US Patents 3,234,258 or 5,075,041 and obtained as commercial products from Shell Oil Company under the name DAN®, are suitable anionic surfactants. Also suitable are the sulfuric

monoesters of the straight-chain or branched C<sub>7-21</sub> alcohols ethoxylated with from 1 to 6 mol of ethylene oxide, such as 2-methyl-branched C<sub>9-11</sub> alcohols containing on average 3.5 mol of ethylene oxide (EO) or C<sub>12-18</sub> fatty alcohols containing from 1 to 4 EO. Preferred anionic surfactants further include the salts of alkylsulfosuccinic acid, which are also referred to as sulfosuccinates or as sulfosuccinic esters and which constitute the monoesters and/or diesters of sulfosuccinic acid with alcohols, preferably fatty alcohols and especially ethoxylated fatty alcohols. Preferred sulfosuccinates comprise C<sub>8-18</sub> fatty alcohol radicals or mixtures thereof. Especially preferred sulfosuccinates contain a fatty alcohol radical derived from ethoxylated fatty alcohols which themselves represent nonionic surfactants. Particular preference is given in turn to sulfosuccinates whose fatty alcohol radicals are derived from ethoxylated fatty alcohols having a narrowed homolog distribution. Similarly, it is also possible to use alk(en)ylsuccinic acid containing preferably 8 to 18 carbon atoms in the alk(en)yl chain, or salts thereof. Further suitable anionic surfactants include fatty acid derivatives of amino acids, for example, of N-methyltaurine (taurides) and/or of N-methylglycine (sarcosides). Particular preference is given here to sarcosides and to the sarcosinates and, of these, especially the sarcosinates of higher fatty acids, which may be mono- or polyunsaturated, such as oleyl sarcosinate. Further suitable anionic surfactants are, in particular, soaps. Suitable soaps include in particular saturated fatty acid soaps, such as the salts of lauric acid, myristic acid, palmitic acid, stearic acid, hydrogenated erucic acid and behenic acid, and, in particular, mixtures of soaps derived from natural fatty acids, e.g., coconut, palm kernel, or tallow fatty acids. Together with these soaps, or as substitutes for soaps, it is also possible to use the known alkenylsuccinic salts.

The anionic surfactants, including the soaps, may be present in the form of their sodium, potassium or ammonium salts and also as soluble salts of organic bases, such as mono-, di- or triethanolamine.  
5 Preferably, the anionic surfactants are in the form of their sodium or potassium salts, in particular in the form of the sodium salts.

In laundry detergents of the invention, surfactants are  
10 present in proportions of preferably from 5% by weight to 50% by weight, in particular from 8% by weight to 30% by weight, whereas compositions for cleaning hard surfaces, especially for the machine cleaning of kitchen- and tableware, have lower surfactant contents  
15 of up to 10% by weight, in particular up to 5% by weight, and preferably in the range from 0.5% by weight to 3% by weight.

A composition of the invention comprises preferably at  
20 least one water soluble and/or water insoluble, organic and/or inorganic builder. The water soluble organic builder substances include polycarboxylic acids, especially citric acid and sugar acids, monomeric and polymeric amino polycarboxylic acids, in particular  
25 methylglycinediacetic acid, nitrilotriacetic acid and ethylenediaminetetraacetic acid, and also polyaspartic acid, polyphosphonic acids, especially aminotris-(methylenephosphonic acid), ethylenediaminetetrakis-(methylenephosphonic acid) and 1-hydroxyethane-1,1-  
30 diphosphonic acid, polymeric hydroxy compounds such as dextrin, and also polymeric (poly)carboxylic acids, especially the polycarboxylates of European Patent EP 0 625 992 or of International Patent Application WO 92/18542 or of European Patent EP 0 232 202, which  
35 are obtainable by oxidizing polysaccharides or, respectively, dextrans; polymeric acrylic acids, methacrylic acids, maleic acids and copolymers thereof, which may also contain in copolymerized form small fractions of polymerizable substances without

carboxylic acid functionality. The relative molecular mass of the homopolymers of unsaturated carboxylic acids is generally between 3000 and 200,000, that of the copolymers between 2000 and 200,000, preferably  
5 from 30,000 to 120,000, based in each case on free acid. A particularly preferred acrylic acid-maleic acid copolymer has a relative molecular mass of from 30,000 to 100,000. Commercially customary products are, for example, Sokalan® CP 5, CP 10 and PA 30 from BASF.  
10 Suitable though less preferred compounds of this class are copolymers of acrylic acid or methacrylic acid with vinyl ethers, such as vinyl methyl ethers, vinyl esters, ethylene, propylene and styrene, in which the acid fraction is at least 50% by weight. As water  
15 soluble organic builder substances it is also possible to use terpolymers containing as monomers two unsaturated acids and/or their salts and, as the third monomer, vinyl alcohol and/or an esterified vinyl alcohol or a carbohydrate. The first acidic monomer or  
20 salt thereof is derived from a monoethylenically unsaturated C<sub>3</sub>-C<sub>8</sub> carboxylic acid and, preferably, from a C<sub>3</sub>-C<sub>4</sub> monocarboxylic acid, especially from (meth)acrylic acid. The second acidic monomer or salt thereof may be a derivative of a C<sub>4</sub>-C<sub>8</sub> dicarboxylic  
25 acid, maleic acid being particularly preferred, and/or a derivative of an allylsulfonic acid substituted in position 2 by an alkyl or aryl radical. Such polymers may be prepared in particular by processes which are described in German Patent DE 42 21 381 and German  
30 Patent Application DE 43 00 772, and generally have a relative molecular mass of between 1000 and 200,000. Further preferred copolymers are those described in German Patent Applications DE 43 03 320 and DE 44 17 734, containing as monomers preferably  
35 acrolein and acrylic acid/acrylic acid salts, and/or vinyl acetate. The organic builder substances, especially for the preparation of liquid compositions, may be used in the form of aqueous solutions, preferably aqueous solutions with a strength of from 30

to 50 percent by weight. All said acids are generally used in the form of their water soluble salts, especially their alkali metal salts.

5 Organic builder substances of this kind may be present, if desired, in amounts of up to 40% by weight, in particular up to 25% by weight, and preferably from 1% by weight to 8% by weight. Amounts close to the stated upper limit are used preferably in pastelike or liquid  
10 compositions of the invention, especially those containing water.

Suitable water soluble inorganic builder materials include, in particular, alkali metal silicates, alkali  
15 metal carbonates and alkali metal phosphates, which may be present in the form of their alkaline, neutral or acidic sodium or potassium salts. Examples thereof are trisodium phosphate, tetrasodium diphosphate, disodium dihydrogen diphosphate, pentasodium triphosphate, so-  
20 called sodium hexametaphosphate, oligomeric trisodium phosphate having degrees of oligomerization from 5 to 1000, especially from 5 to 50, and also the corresponding potassium salts and/or mixtures of sodium and potassium salts. Water insoluble, water dispersible  
25 inorganic builder materials used are, in particular, crystalline or amorphous alkali metal aluminosilicates, in amounts of up to 50% by weight, preferably not more than 40% by weight, and in liquid compositions in particular from 1% by weight to 5% by weight. Among  
30 these, preference is given to the crystalline sodium aluminosilicates of detergent quality, especially zeolite A, P and, if appropriate, X, alone or in mixtures, in the form for example of a cocrystallizate of zeolites A and X (Vegobond® AX, a commercial product from Condea  
35 Augusta S.p.A.). Amounts close to the stated upper limit are used preferably in solid, particulate compositions. Suitable aluminosilicates possess in particular no particles having a size of more than 30  $\mu\text{m}$ , and preferably consist at least 80% by weight of

particles having a size below 10  $\mu\text{m}$ . Their calcium binding capacity, which may be determined in accordance with the information in German Patent DE 24 12 837, is generally in the range from 100 to 200 mg of CaO per gram.

Suitable substitutes or partial substitutes for said aluminosilicate are crystalline alkali metal silicates, which may be present alone or in a mixture with amorphous silicates. The alkali metal silicates which can be used as builders in the compositions of the invention preferably have a molar ratio of alkali metal oxide to  $\text{SiO}_2$  of below 0.95, in particular from 1:1.1 to 1:12, and may be present in amorphous or crystalline form. Preferred alkali metal silicates are the sodium silicates, especially the amorphous sodium silicates, having a molar ratio  $\text{Na}_2\text{O}:\text{SiO}_2$  of from 1:2 to 1:2.8. Those with a molar ratio  $\text{Na}_2\text{O}:\text{SiO}_2$  of from 1:1.9 to 1:2.8 may be prepared by the process of European Patent Application EP 0 425 427. As crystalline silicates which may be present alone or in a mixture with amorphous silicates it is preferred to use crystalline phyllosilicates of the general formula  $\text{Na}_2\text{Si}_x\text{O}_{2x+1} \cdot y\text{H}_2\text{O}$ , where x, the so-called modulus, is a number from 1.9 to 22, in particular from 1.9 to 4, and y is a number from 0 to 33, and preferred values for x are 2, 3 or 4. Crystalline phyllosilicates which fall under this general formula are described, for example, in European Patent Application EP 0 164 514. Preferred crystalline phyllosilicates are those where x in the stated general formula adopts the values 2 or 3. In particular, both  $\beta$ - and  $\delta$ -sodium disilicates ( $\text{Na}_2\text{Si}_2\text{O}_5 \cdot y\text{H}_2\text{O}$ ) are preferred, with  $\beta$ -sodium disilicate, for example, being obtainable by the process described in International Patent Application WO 91/08171.  $\delta$ -Sodium silicates having a modulus of between 1.9 and 3.2 may be prepared in accordance with Japanese Patent Applications JP 04/238 809 and JP 04/260 610. In addition, virtually anhydrous crystalline alkali metal silicates of the

abovementioned general formula wherein x is a number from 1.9 to 2.1, prepared from amorphous alkali metal silicates, and preparable as described in European Patent Applications EP 0 548 599, EP 0 502 325 and  
5 EP 0 452 428, may be used in compositions of the invention. In a further preferred embodiment of compositions of the invention, a crystalline sodium phyllosilicate having a modulus of from 2 to 3 is used, as may be prepared from sand and soda by the process of  
10 European Patent Application EP 0 436 835. Crystalline sodium silicates having a modulus in the range from 1.9 to 3.5, as are obtainable by the processes of European Patents EP 0 164 552 and/or EP 0 294 753, are used in a further preferred embodiment of compositions of the  
15 invention. Crystalline sheetlike silicates of the abovementioned formula are sold by Clariant GmbH under the trade name Na-SKS, e.g., Na-SKS-1 ( $\text{Na}_2\text{Si}_{22}\text{O}_{45} \cdot x\text{H}_2\text{O}$ , kenyaite), Na-SKS-2 ( $\text{Na}_2\text{Si}_{14}\text{O}_{29} \cdot x\text{H}_2\text{O}$ , magadiite), Na-SKS-3 ( $\text{Na}_2\text{Si}_8\text{O}_{17} \cdot x\text{H}_2\text{O}$ ) or Na-SKS-4 ( $\text{Na}_2\text{Si}_4\text{O}_9 \cdot x\text{H}_2\text{O}$ , makatite).  
20 Of these, those particularly suitable include Na-SKS-5 ( $\alpha\text{-Na}_2\text{Si}_2\text{O}_5$ ), Na-SKS-7 ( $\beta\text{-Na}_2\text{Si}_2\text{O}_5$ , natrosilite), Na-SKS-9 ( $\text{NaHSi}_2\text{O}_5 \cdot 3\text{H}_2\text{O}$ ), Na-SKS-10 ( $\text{NaHSi}_2\text{O}_5 \cdot 3\text{H}_2\text{O}$ , kanemite), Na-SKS-11 ( $t\text{-Na}_2\text{Si}_2\text{O}_5$ ) and Na-SKS-13 ( $\text{NaHSi}_2\text{O}_5$ ), but especially Na-SKS-6 ( $\delta\text{-Na}_2\text{Si}_2\text{O}_5$ ). A review of  
25 crystalline phyllosilicates is given, for example, by the articles published in "Hoechst High Chem Magazin 14/1993" on pages 33-38 and in "Seifen-Öle-Fette-Wachse, Vol. 116, No. 20/1990" on pages 805-808. In one preferred embodiment of compositions of the invention,  
30 use is made of a granular compound of crystalline phyllosilicate and citrate, of crystalline phyllosilicate and abovementioned (co)polymeric polycarboxylic acid, as is described, for example, in German Patent Application DE 198 19 187, or of alkali  
35 metal silicate and alkali metal carbonate, as is described, for example, in International Patent Application WO 95/22592 or as is available commercially, for example, under the name Nabion® 15.



Builder substances may be present in the compositions of the invention, if desired, in amounts of up to 90% by weight. They are preferably present in amounts of up to 75% by weight. Laundry detergents of the invention  
5 have builder contents of in particular from 5% by weight to 50% by weight. In compositions of the invention for cleaning hard surfaces, especially for the machine cleaning of kitchen- and tableware, the amount of builder substances is in particular from 5%  
10 by weight to 88% by weight, preferably no water insoluble builder materials being used in such compositions. In a preferred embodiment of compositions of the invention intended in particular for the machine washing of kitchen- and tableware, from 20% by weight  
15 to 40% by weight of water soluble organic builder, especially alkali metal citrate, from 5% by weight to 15% by weight of alkali metal carbonate, and from 20% by weight to 40% by weight of alkali metal disilicate are present.

20

Peroxygen compounds suitable for use in compositions of the invention include, in particular, organic peracids or peracidic salts of organic acids, such as phthalimidopercaproic acid, perbenzoic acid or salts of  
25 diperdodecanedioic acid, hydrogen peroxide, and inorganic salts which give off hydrogen peroxide under the washing conditions, including perborate, percarbonate, persilicate and/or persulfate such as Caroate. Where solid peroxygen compounds are to be  
30 used, they may be employed in the form of powders or granules, which may also have been coated in a manner which is known in principle. Where a composition of the invention does comprise peroxygen compounds, they are present in amounts of preferably up to 50% by weight,  
35 in particular from 5% by weight to 30% by weight and particularly preferably from 8% by weight to 25% by weight. The addition of small amounts of known bleach stabilizers such as, for example, of phosphonates, borates and/or metaborates and metasilicates, and also

magnesium salts such as magnesium sulfate, may be judicious.

In addition to the bleach activating compound of formula I, it is possible to use customary compounds which under perhydrolysis conditions give off peroxo-carboxylic acid, so-called bleach activators. Bleach activators which may be used are, in particular, compounds which under perhydrolysis conditions give rise to aliphatic peroxo carboxylic acids having preferably 1 to 10 carbon atoms, in particular 2 to 4 carbon atoms, and/or substituted or unsubstituted perbenzoic acid. Suitable substances are those which carry O-acyl and/or N-acyl groups of the stated number of carbon atoms, and/or substituted or unsubstituted benzoyl groups. Preference is given to polyacylated alkylenediamines, especially tetraacetylenediamine (TAED), acylated triazine derivatives, especially 1,5-diacetyl-2,4-dioxohexahydro-1,3,5-triazine (DADHT), acylated glycolurils, especially tetraacetylglycoluril (TAGU), N-acyl imides, especially N-nonanoylsuccinimide (NOSI), acylated phenolsulfonates, especially n-nonanoyl- or isononanoyloxybenzenesulfonate (n- or iso-NOBS), carboxylic anhydrides, especially phthalic anhydride, acylated polyhydric alcohols, especially triacetin, ethylene glycol diacetate, 2,5-diacetoxy-2,5-dihydrofuran, and the enol esters known from German Patent Applications DE 196 16 693 and DE 196 16 767, and also acetylated sorbitol and mannitol and/or the mixtures thereof (SORMAN) described in European Patent Application EP 0 525 239, acylated sugar derivatives, especially pentaacetylglucose (PAG), pentaacetylfructose, tetraacetylxylose and octaacetyllactose, and acetylated, optionally N-alkylated glucamine and gluconolactone, and/or N-acylated lactams, for example, N-benzoylcaprolactam, which are known from International Patent Applications WO 94/27970, WO 94/28102, WO 94/28103, WO 95/00626, WO 95/14759 and WO 95/17498. The hydrophilically substituted

acylacetals known from German Patent Application DE 196 16 769 and acyllactams described in German Patent Application DE 196 16 770 and in International Patent Application WO 95/14075 are likewise used with  
5 preference. The combinations of conventional bleach activators known from German Patent Application DE 44 43 177, may also be used. Such bleach activators may be present in customary quantities, preferably in amounts of from 0.5% by weight to 10% by weight, and in  
10 particular from 1% by weight to 8% by weight, based on overall composition. In addition to the conventional bleach activators, or instead of them, it is also possible for the sulfonimines known from European Patents EP 0 446 982 and EP 0 453 003 to be present  
15 and/or for bleach catalyzing transition metal salts or complexes to be present, in particular in amounts of from 0.001% by weight to 0.5% by weight.

Enzymes which may be used in the compositions in  
20 addition to the amylase that is essential to the invention include those from the class of the proteases, lipases, cutinases, pullulanases, hemicellulases, cellulases, oxidases, laccases and peroxidases, and mixtures thereof. If desired, amylases  
25 other than the amylase essential to the invention may be present in addition to it. Particularly suitable active enzymatic substances are those obtained from fungi or bacteria, such as *Bacillus subtilis*, *Bacillus licheniformis*, *Bacillus lentus*, *Streptomyces griseus*,  
30 *Humicola lanuginosa*, *Humicola insolens*, *Pseudomonas pseudoalcaligenes*, *Pseudomonas cepacia* or *Coprinus cinereus*. The amylase essential to the invention and the enzymes that may be used in addition may - as described, for example, in European Patent EP 0 564 476  
35 or in International Patent Application WO 94/23005 - be adsorbed on carrier substances and/or embedded in coating substances in order to protect them against premature inactivation. In the detergents of the invention they are present preferably in amounts of up

to 5% by weight, in particular from 0.2% by weight to 4% by weight. Where the composition of the invention comprises protease, it preferably has a proteolytic activity in the range from about 100 PU/g to about 10,000 PU/g, in particular from 300 PU/g to 8000 PU/g. Where two or more enzymes are to be used in the composition of the invention, this may be accomplished by incorporating the two or more separate, or conventionally separately compounded enzymes, or by means of two or more enzymes compounded together in granules, as known, for example, from International Patent Applications WO 96/00772 or WO 96/00773.

The organic solvents which may be used besides water in the compositions of the invention, especially if they are present in liquid or paste form, include alcohols having 1 to 4 carbon atoms, especially methanol, ethanol, isopropanol and tert-butanol, diols having 2 to 4 carbon atoms, especially ethylene glycol and propylene glycol, and also mixtures thereof and the ethers derivable from the aforementioned classes of compound. Water miscible solvents of this kind are present in the compositions of the invention preferably in amounts of not more than 30% by weight, in particular from 6% by weight to 20% by weight.

Additionally, the compositions may comprise further constituents customary in detergents. These optional constituents include, in particular, enzyme stabilizers, graying inhibitors, color transfer inhibitors, foam inhibitors, and optical brighteners and also dyes and fragrances. In order to protect against silver corrosion, silver corrosion inhibitors may be used in dishwashing detergents of the invention. A cleaning product of the invention for hard surfaces may, furthermore, comprise abrasive constituents, especially from the group consisting of quartz flours, wood flours, polymer flours, chalks and glass microbeads, and mixtures thereof. Abrasives are present

in the detergents of the invention preferably at not more than 20% by weight, in particular from 5% by weight to 15% by weight.

5 In order to adjust the pH to a desired level which does not come about of itself through the mixing of the other components, the compositions of the invention may comprise system-compatible and environmentally compatible acids, especially citric acid, acetic acid,  
10 tartaric acid, malic acid, lactic acid, glycolic acid, succinic acid, glutaric acid and/or adipic acid, or else mineral acids, especially sulfuric acid, or bases, especially ammonium hydroxides or alkali metal hydroxides. pH regulators of this kind are present in  
15 the compositions of the invention in amounts of preferably not more than 20% by weight, in particular from 1.2% by weight to 17% by weight.

The color transfer inhibitors suitable for use in  
20 laundry detergents of the invention include, in particular, polyvinylpyrrolidones, polyvinylimidazoles, polymeric N-oxides such as poly(vinylpyridine N-oxide), and copolymers of vinylpyrrolidone with vinylimidazole.

25 Graying inhibitors have the function of keeping the soil detached from the textile fiber in suspension in the liquor. Suitable for this purpose are water soluble colloids, usually organic in nature, examples being starch, glue, gelatin, salts of ether carboxylic acids  
30 or ether sulfonic acids of starch or of cellulose, or salts of acidic sulfuric esters of cellulose or of starch. Water soluble polyamides containing acidic groups are also suitable for this purpose. Furthermore, starch derivatives other than those mentioned above may  
35 be used, aldehyde starches, for example. Preference is given to cellulose ethers, such as carboxymethylcellulose (Na salt), methylcellulose, hydroxyalkylcellulose and mixed ethers, such as methylhydroxyethylcellulose, methylhydroxypropyl-

cellulose, methylcarboxymethylcellulose, and mixtures thereof, in amounts, for example, of from 0.1 to 5% by weight, based on the compositions.

5 As optical brighteners, laundry detergents of the invention may comprise derivatives of diaminostilbene-disulfonic acid and/or its alkali metal salts. Suitable, for example, are salts of 4,4'-bis(2-anilino-4-morpholino-1,3,5-triazinyl-6-amino)stilbene-2,2'-di-  
10 sulfonic acid or compounds of similar structure which instead of the morpholino group carry a diethanolamino group, a methylamino group, an anilino group, or a 2-methoxyethylamino group. It is also possible for brighteners of the substituted diphenylstyryl type to  
15 be present, for example, the alkali metal salts of 4,4'-bis(2-sulfostyryl)biphenyl, 4,4'-bis(4-chloro-3-sulfostyryl)biphenyl, or 4-(4-chlorostyryl)-4'-(2-sulfostyryl)biphenyl. Mixtures of the aforementioned optical brighteners may also be used.

20

Especially for use in machine processes, it may be of advantage to add customary foam inhibitors to the compositions. Examples of suitable foam inhibitors are soaps of natural or synthetic origin having a high  
25 C<sub>18</sub>-C<sub>24</sub> fatty acid fraction. Examples of suitable nonsurfactant-type foam inhibitors are organopolysiloxanes and their mixtures with microfine, optionally silanized silica and also paraffins, waxes, microcrystalline waxes, and mixtures thereof with  
30 silanized silica or bis-fatty acid alkylene diamides. With advantages, use is also made of mixtures of different foam inhibitors, for example, mixtures comprising silicones, paraffins, or waxes. The foam inhibitors, especially those containing silicone and/or  
35 paraffin, are preferably bound on a granular, water soluble or dispersible support substance. Particular preference is given to mixtures of paraffins and bisstearylethylenediamide.

The production of solid compositions of the invention presents no difficulties and may be done conventionally, for example, by spray drying or granulation, with the enzymes and any other heat  
5 sensitive ingredients such as bleaches, for example, being added separately later on if desired. To produce compositions of the invention of heightened bulk density, in particular in the range from 650 g/l to 950 g/l, preference is given to a process known from  
10 European Patent EP 0 486 592 which includes an extrusion step. Another preferred preparation, with the aid of a granulation process, is described in European Patent EP 0 642 576.

15 To produce compositions of the invention in tablet form, which may have one or more phases, may have one or more colors, and consist in particular of one layer or of two or more layers, in particular of two layers, it is preferred to follow a procedure in which all of  
20 the constituents - per one layer if appropriate - are mixed with one another in a mixer and the mixture is compressed by means of conventional tableting presses, for example, eccentric presses or rotary presses, at pressing forces in the range from about 50 to 100 kN,  
25 preferably from 60 to 70 kN. Especially in the case of multilayer tablets it may be of advantage if at least one layer is compressed beforehand. This is preferably accomplished at pressing forces of between 5 and 20 kN, in particular from 10 to 15 kN. In this way, tablets  
30 which are fracture resistant and yet dissolve sufficiently quickly under application conditions are obtained without problems, having fracture strengths and flexural strengths of normally from 100 to 200 N, but preferably above 150 N. A tablet produced in this  
35 way preferably has a weight of from 10 g to 50 g, in particular from 15 g to 40 g. The three-dimensional form of the tablets is arbitrary and may be circular, oval or angular, with intermediate forms also being possible. Corners and edges are advantageously rounded.

Circular tablets preferably have a diameter of from 30 mm to 40 mm. In particular, the size of tablets of angular or cuboid design which are introduced predominantly by way of the dosing apparatus of, for example, the dishwashing machine is dependent on the geometry and on the volume of this dosing apparatus. Embodiments which are preferred by way of example have a basal area of (from 20 to 30 mm) × (from 34 to 40 mm), in particular of 26×36 mm or of 24×38 mm.

Liquid or paste detergents of the invention in the form of solutions comprising customary solvents are generally prepared by simply mixing the ingredients, which may be introduced in bulk or in solution into an automatic mixer.

### Examples

#### Example 1

To determine the washing power, cotton fabrics soiled with standardized test stains were washed at 40°C (detergent dosing 76 g; water hardness 16 °d [German hardness]; load 3.5 kg, short programme) in a domestic washing machine (Miele® W701). Washing was carried out using a detergent **V1** containing 0.25% by weight of noninventive amylase granules (Termamyl® 60T), 0.25% by weight of protease granules (activity 200 000 PU/g) containing the Bacillus lentus protease, and 18% by weight of sodium perborate, and also 5% by weight of N-methylmorpholiniumacetoneitrile methosulfate, a detergent **V2** of otherwise the same composition but containing, instead of Termamyl®, the protein-equivalent amount of the genetically modified amylase Duramyl®, a detergent **V3** of otherwise the same composition as **V1** but containing, instead of Termamyl®, the protein-equivalent amount of the genetically modified amylase Purafect® OxAm, a detergent **V4** of otherwise the same composition as **V1** but containing,



instead of Termamyl®, the protein-equivalent amount of the fungal amylase Fungamyl®, and an inventive detergent **M1** which was of otherwise the same composition as **V1** but containing, instead of Termamyl®,  
5 the protein-equivalent amount of the amylase from Bacillus amyloliquefaciens.

The compositions of the invention had a wash performance which was markedly superior to that of the  
10 compositions containing a different amylase. The situation is essentially the same when in the composition of the invention the acetonitrile derivative was replaced by the conventional bleach activator TAED.

15

#### Example 2

Detergents (**V5** and **V6**, respectively) for the machine washing of kitchen- and tableware, comprising 55% by  
20 weight sodium tripolyphosphate (calculated as anhydrous), 4% by weight amorphous sodium disilicate (calculated as anhydrous), 22% by weight sodium carbonate, 9% by weight sodium perborate, 2% by weight N-methylmorpholiniumacetonitrile methosulfate, 2% by  
25 weight nonionic surfactant, and also 1% by weight or 2% by weight amylase granules (Termamyl® 60T), respectively, and 1.4% by weight protease granules (activity 200,000 PU/g) comprising the Bacillus lentus protease (remainder to 100% by weight water, perfume  
30 and dye), compositions (**V7** and **V8**, respectively) whose composition was otherwise like that of **V5** and **V6**, respectively, but which instead of Termamyl® contained protein-equivalent amounts of Duramyl®, and also compositions in accordance with the invention (**M3** and  
35 **M4**, respectively), whose composition was otherwise like that of **V5** and **V6**, but which instead of Termamyl® contained protein-equal amounts of amylase from Bacillus amyloliquefaciens, respectively, were tested as indicated below:

In a Miele® G 575 dishwasher (additions of 20 g of each test composition in the universal program, water hardness 14-16°dH [German hardness], operating temperature 55°C), in each case 6 plates soiled with standardized starch stains or bleachable stains were washed and the remaining stain residue was determined gravimetrically and related to the initial value prior to washing (i.e., 100%). The compositions of the invention were significantly superior to the noninventive compositions in cleaning performance. Essentially the same is true if the acetonitrile derivative in the composition of the invention was replaced by the conventional bleach activator TAED.

What is claimed is:

1. An amylase containing detergent, characterized in that it comprises  $\alpha$ -amylase from *Bacillus amyloliquefaciens* and at least one compound of the general formula I



where  $R^1$ ,  $R^2$  and  $R^3$  independently of one another are alkyl, alkenyl or aryl groups of 1 to 18 carbon atoms, it also being possible for groups  $R^2$  and  $R^3$  to be part of a heterocycle including the nitrogen atom and, if desired, further heteroatoms, and X is a charge equalizing anion, as well as customary ingredients compatible with such constituents.

2. The composition as claimed in claim 1, characterized in that it contains amylase in amounts of from 0.001 mg to 0.5 mg, in particular from 0.02 mg to 0.3 mg, per gram of the overall composition.

3. The composition as claimed in claim 1 or 2, characterized in that in the compound of formula I  $R^2$  and  $R^3$  including the quaternary nitrogen atom form a morpholinium ring.

4. The composition as claimed in claim 3, characterized in that in the compound of formula I  $R^1$  is an alkyl group of 1 to 3 carbon atoms, in particular a methyl group.

5. The composition as claimed in any of claims 1 to 4, characterized in that in the compound of formula I the charge equalizing anion  $X^-$  is selected from the halides, such as chloride, fluoride, iodide and bromide, nitrate, hydroxide,

hexafluorophosphate, sulfate, hydrogen sulfate, methosulfate and ethosulfate, chlorate, perchlorate, and the anions of carboxylic acids, such as formate, acetate, benzoate or citrate.

- 5
6. The composition as claimed in any of claims 1 to 5, characterized in that in the compound of formula I the charge equalizing anion  $X^-$  is sulfate, hydrogen sulfate or methosulfate.
- 10
7. The composition as claimed in any of claims 1 to 6, characterized in that it contains from 1% by weight to 10% by weight, in particular from 2% to 7% by weight, of a compound of the general formula
- 15 I.
8. The composition as claimed in any of claims 1 to 7, characterized in that it contains from 5% by weight to 30% by weight, in particular from 8% by
- 20 weight to 25% by weight, of oxygen-based bleach.
9. The composition as claimed in claim 8, characterized in that it comprises a peroxygen compound from the group consisting of organic
- 25 peracids, hydrogen peroxide, alkali metal perborate and alkali metal percarbonate and mixtures thereof.
10. The composition as claimed in any of claims 1 to 9, characterized in that, in addition to the compounds of formula I, from 0.5% by weight to 10% by weight, in particular from 1% by weight to 8% by weight, of compounds which under perhydrolysis conditions give off peroxy-carboxylic acids are
- 30 present.
- 35
11. The composition as claimed in any of claims 1 to 10, characterized in that, in addition to the compound of formula I, bleach catalyzing

transition metal salts or complexes are present, in particular in amounts of from 0.001% by weight to 0.5% by weight.

- 5 12. The use of a combination of  $\alpha$ -amylase from *Bacillus amyloliquefaciens* and a compound of formula I



10

where  $R^1$ ,  $R^2$  and  $R^3$  independently of one another are alkyl, alkenyl or aryl groups of 1 to 18 carbon atoms, it also being possible for the groups  $R^2$  and  $R^3$  to be part of a heterocycle including the nitrogen atom and, if desired, further heteroatoms, and X is a charge equalizing anion, for enhancing the cleaning performance of detergents when used in washing and cleaning solutions, especially aqueous washing and cleaning solutions, which comprise a peroxygen compound.

15

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13. The use as claimed in claim 12, wherein the cleaning performance is enhanced in relation to starchy and/or colored stains, especially tea-based stains.
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